Surgeons experience more **ergonomic stress** in the OR

by Jeannie Glickson
Ramon Berguer, MD, FACS, chief of surgery at Contra Costa Regional Medical Center in Martinez, CA, near San Francisco, recalls that during his residency in the late 1980s at the University of Colorado Hospital, Denver, laparoscopic surgical procedures were coming of age. “Gynecologic surgeons were the first to popularize laparoscopic surgery,” Dr. Berguer said, “and these minimally invasive procedures were quickly transforming the way surgeons did their jobs.”

As Dr. Berguer performed increasingly complex laparoscopic procedures, he noticed that his shoulders, arms, neck, back, and wrists ached after he left the operating room (OR). He also began to notice a host of other work issues in the laparoscopic OR, with its “incredible tangle of wires and cables”—and a potential minefield of physical injury to health care staff and medical errors.

Dr. Berguer now refers to matters involving the laparoscopic surgeon and the equipment, systems, and processes in the OR as the physical and psychological interaction between the users and their tools—in a word, ergonomics. “Surgeons depend on tools to conduct their trade,” Dr. Berguer said. Stressing the importance of ergonomic issues, he added, “How we work with these tools affects not only the length of the procedure and the overall morbidity of our patients, but also how comfortably we can use our limbs and muscles when we leave the OR.”

Adrian Park, MD, FACS, chairman of the department of surgery at Anne Arundel Medical Center in Annapolis, MD, and adjunct professor of computer science at the University of Maryland, Baltimore, speaks of a similar introduction to ergonomics.

“I was one of the guys on the ground floor of minimally invasive surgery (MIS),” Dr. Park said. “I was young and physically active and all gung-ho on MIS, even though I was trained [in] performing open operations.”

Dr. Park quickly realized the “pervasive toll” of MIS. “Even as a young guy,” he said. “I thought to myself that I couldn’t keep this up for the length of a career.”

“Surgeons are not ones to hold back on their complaints,” Dr. Park added, “but when it comes to our own health, we are slow to act. We turn our bodies into pretzels for the best outcome for the patient, and this strenuous activity is just not sustainable. Laparoscopic procedures are beneficial for patients, and clearly, the technique is here to stay,” Dr. Park said, “but surgeons need to look out for their own well-being as well.”

An ergonomic crisis

Surgeons are facing an ergonomic crisis, according to Peter F. Nichol, MD, PhD, FACS, assistant professor, section chief of pediatrics, department of surgery, University of Wisconsin School of Medicine and Public Health, Madison. “Ergonomics may be the most important issue facing surgeons today,” he said, adding that problems occur during both laparoscopic and open procedures.

The current crisis, Dr. Nichol said, is a product of surgeons’ increased workload. “There are 330 million people in the U.S. [compared with about 263 million in 1995] and the same number of surgeons [as in 1995],” he said. “Surgeons are working harder and paying a higher physical price.”

This undersupply of surgeons adds to the stress of the OR environment and may have a negative effect on quality of care. “It’s an industrial truth that the more stress you put on human beings, the more mistakes they make,” Dr. Nichol said. Medical devices are vital to the surgical procedure, but many do not adhere to basic ergonomics, he said, pointing to the one-size-fits-all oversight inherent in many of today’s surgical instruments.

“Industry hasn’t been paying attention,” according to Dr. Nichol. “I’m hearing from a lot of angry surgeons out there who want things to change.” He noted that there are consequences when the medical industry fails to respond to ergonomic issues: The U.S. Food and Drug Administration estimates that the poor design of medical instruments accounts for half of the 1.3 million unintentional patient injuries in U.S. hospitals each year.2,3
Surgeons can look to external forces to ease the strains of their jobs, but it’s important for them to re-evaluate their own habits as well, according to Dr. Nichol. “The work of surgeons is incredibly hard on the human body,” he said, and surgeons need to be in the best possible physical condition. “We need to find ways to keep our bodies durable over the course of a 30-year career,” he said. “I like to say that we need to train like ultra-marathoners.”

Because surgeons are often on their feet and moving around for 12-hour periods, the overall stress and strain on their bodies is enormous. “We should be weightlifting two or three times a week and doing aerobic exercise twice a week for 30 to 40 minutes, to be in shape for the challenge. And we should be eating foods that will enable us to get through the day,” Dr. Nichol said. “Our bodies have been abused and neglected,” Dr. Nichol continued. “Many of us are sleep-deprived. My point is that we have to change the way we look at ourselves and change our behavior.”

Ergonomics should be taught during surgical training, according to Dr. Berguer. “Surgeons generally learn their craft in an environment that discourages complaints about stress and fatigue,” he said. “Medical schools do not teach surgeons to take breaks,” Dr. Berguer added. “We are trained to work until we finish the job. But I’ve found that every 30 or 40 minutes, it helps to take my eyes off the operation and take a 30-second break.”

As Thomas Krummel, MD, FACS, lightheartedly observed, “Most surgeons are ‘suck-it-up’ guys and gals. We tend not to complain about our own physical discomfort. We put the needs of our patients first.” Dr. Krummel is Emile Holman Professor and Chairman, department of surgery, Stanford University School of Medicine (SUSM) in Palo Alto, CA; Susan B. Ford Surgeon-In-Chief, Lucile Packard Children’s Hospital; and co-director, Biodesign Program at Stanford University. But sentiments may be shifting. Dr. Krummel, Dr. Nichol, and Dr. Park were among several speakers at a 2011 American College of Surgeons Clinical Congress panel session titled “Surgeon Wear and Tear: The Hidden Cost of Adverse Ergonomics.”

“I was stunned by the number of people who attended the session,” Dr. Krummel said. “I don’t consider myself an ergonomic expert. I’m just a surgeon in the trenches. But the fact that people stayed long after the program to continue the discussion says to me that we are all experts to some degree, and the discussion needs to continue.”

Understanding the surgical workplace

It is especially important to continue the discussion as MIS becomes the norm for many operations. “With MIS, you’re holding instruments in weird, unsupported positions, and today, 20 years after we began using these procedures, we’re seeing the wear and tear they have on surgeons,” according to Sherry Wren, MD, FACS, associate dean, academic affairs; professor of surgery, SUSM, and chief, general surgery, Palo Alto Veterans Health Care System. Laparoscopic practice left Dr. Wren in need of surgical repair of her rotator cuff, which sidelined her from the OR for more than three months and involved more than a year of physical therapy. To offset the often-debilitating effects of MIS, she depends more today on robot-assisted surgery. “There are drawbacks to using robots, but it’s a lot easier on me to sit in a console and let a robot do all the twisting and bending.” The long-term benefits of robot-assisted surgery, Dr. Berguer noted, will depend on the balance between ergonomic improvements and the cost of the systems.

The setup in a standard OR is not always optimal for performing laparoscopic procedures, Dr. Berguer said. Indeed, most minimally invasive surgical procedures take place in ORs that were designed for traditional open surgery.4

Walk into a laparoscopic OR, and you are likely to find a maze of tubes and cables that cross the workspace, and create obstructions and hazards to personnel and equipment. Laparoscopic operations have tripled the number of cables and tubes that touch the surgeon or assistant. These cables are both a hindrance to movement and a potential source of breaks in aseptic technique. The multiple tubes also create an elaborate background that can decrease the efficient use of instrument handling, positioning, and exchanges.5

The Occupational Safety & Health Administration (OSHA) of the U.S. Department of Labor has pointed out that the wires pose a tripping hazard, and it is not uncommon for health care workers to attach the wrong device to the wrong cable.6 Among OSHA suggestions: ORs could provide ceiling or floor outlets for equipment to ensure that power cords do not run across pathways. Also, practitioners could make mobile equipment more visible by marking it with a bright color or a taped “X.”6

In addition, researchers found that the percentage of total floor space occupied by humans, furniture,
Ergonomic impact of laparoscopy

A number of issues—including the awkward positions endured by surgeons and the placement of the operating table and monitor—add to the stress of the OR. The long laparoscopic instruments and the resulting pain and stiffness that surgeons experience after operations add to the physical and psychological toll.

Traditional laparoscopy forces the fulcrum effect on surgeons, requiring them to move their hands in the opposite direction of the instrument’s tip. The surgeon’s hand moves left, and the instrument tip moves right. Laparoscopic surgery changes the way that surgeons interact with the surgical field, Dr. Berguer explained, noting first the impact that MIS has on the surgeon’s posture. The hand-held instrument design, the position of the monitor, the use of foot pedals to control diathermy, the height of the operating table, and the static body posture all affect the practitioner’s posture in the OR, he said.

The fixed-position entry ports limit the ability to adjust instrument position and angles, Dr. Berguer said. Handheld laparoscopic instruments offer only four degrees of freedom, a factor that, when combined with the fixed entry positions, limits the surgeon’s ability to position instruments optimally. Laparoscopic surgeons, therefore, lack the freedom to move around during a procedure and, as a result, tend to shift their weight and flex their necks, which leads to more muscle strain and soreness.

“In open surgery,” Dr. Berguer said, “we look and touch patients’ tissue directly using our hands or simple tools.” Dr. Park explained, “In open surgery, your fingers and wrists directly interact with the target anatomy.” The long laparoscopic instruments that reach inside the closed abdomen are more awkward and difficult to use than open instruments. “With laparoscopic instruments, the surgeon is essentially using a chopstick,” Dr. Park continued. “The result is that our senses must work much harder to achieve the same goals.”

During laparoscopic procedures, surgeons no longer look directly at the operating site, as they would during an open operation, but rather at a display. The surgeon must separate the visual and the physical, blending the view on the display and the mechanical feedback from the arms and hands to manipulate the tissue. Under these conditions, Dr. Park said, it takes surgeons more time and physical and mental effort to complete manipulative tasks.

Laparoscopic surgeons, according to Dr. Berguer, must force the instruments harder, bend their wrists more, and hold their arms higher than during an open procedure. These combined factors, he said, can produce substantial hand and shoulder fatigue and soreness. The surgeon works through small ports of 3 to 10 mm, he explained, which, through complex internal mechanical linkage, decrease the efficient transmission of force from the surgeon’s hand to the instrument tip. The surgeon has to work as much as six times harder to accomplish the same grasping task with the laparoscopic instruments, compared with an open operation, Dr. Berguer said. This increase in force, he added, tends to magnify other problems, such as poor handle design and handles too large for small-handed surgeons. Poorly designed instruments create tension and strain in the hands and can even damage the nerves of the thumb.

“The large instruments are problems for many women with smaller hands but actually for anyone with small hands,” said Dr. Wren, who wears a size 5.5 glove. “Anyone with a glove size of 6.5 and lower can develop chronic paresthesias from handling the large instruments.” There has been little monetary incentive to fix the problem, she said, but noted that women now represent more than 40 percent of all surgeons-in-training, and industrial partners may have to respond to the changing demographics.

Medical device manufacturers have responded with motor-assisted staplers, Dr. Wren said, which ease...
the strain of the two-handed force required for using surgical staples. Battery-powered staplers offer the ease of push-button control.

The position of the display monitor also affects ergonomics, Dr. Berguer said. The laparoscopic surgeon views the entire procedure on a display device that is no longer positioned near the surgeon’s hands, and typically sits away from the surgeon. In many cases, the monitor rests on the top of a laparoscopic equipment cart, which usually means that the monitor is at or above the surgeon’s eye level.

According to Dr. Berguer, the preferred viewing angle for the video display is 10 to 25 degrees below the user’s eye level. When the display monitor appears at or above the surgeon’s eye, the surgeon’s neck is extended in a stressful and ergonomically damaging pose. One positive development is the advent of flat screen monitors, he noted, which prevent subtle viewing distortions and cause less eye strain. Video display devices mounted on flexible booms allow the surgeon to alter the position of the monitor to obtain the ideal angle between eye level and monitor.10

Laparoscopic instruments change the relationship between the surgeon’s height and the ergonomically sound height of the operating room table.11 Surgeons should insert the laparoscopic instrument handles roughly at, or slightly below, the level of their elbows, according to Dr. Berguer. The laparoscopic table may not lower sufficiently, which leads to human fatigue when surgeons must elevate their arms during the procedure. The height of the table can also affect the upper joint movements of the shoulders, arms, and wrists during laparoscopy.11

Surgeons who use foot pedals should align themselves in the same direction as the instrument, toward the target quadrant and principal lap monitors.12 This setup permits practitioners to activate the pedal without twisting their bodies or legs. If the surgeon is standing on a lifting platform, the pedal should be placed at some level off the ground. A pedal with a built-in footrest is preferable so that surgeons don’t have to hold their foot in the air or move back and forth on the floor.12

In addition, the static postures that surgeons adopt when performing MIS tend to be more disabling and harmful than dynamic postures, as the muscles and tendons develop lactic acidosis and build up toxins when held in a static position, according to Dr. Berguer. Most open surgery requires standing, awkward body positions, and the need to exert force on tissues. But surgeons performing laparoscopic procedures move around less than during open surgery and hold a body posture longer, increasing their physical fatigue, Dr. Berguer said. The surgeon’s static position during MIS probably reflects the increased concentration required to perform surgery with indirect vision and less efficient instruments.7

Some ergonomic problems in surgery may be unsolvable. “There may not be a technical fix for every technical difficulty we’re discussing,” Dr. Wren said.

**Studying the impact of ergonomics**

Measuring the stress and strain imposed on a surgeon during a procedure presents its own challenges. The surgeon must wear a number of devices in order to be studied, including reflecting markers, motion
sensors, and electrodes (see an example of such a study, conducted at Yale University laparoscopic cholecystectomy lab, in the photo on page 24). Markers applied to the surgeon’s clothing may not stay intact during the procedure, and it is unknown how much the applied wires will affect the surgeon during an operation. For these reasons, researchers apply most of their research not during an actual operation but during laboratory experiments.13

Early surveys reported that 20 to 30 percent of surgeons experienced ergonomic problems, according to Dr. Park. But a 2010 survey—conducted by Dr. Park and colleagues at the University of Maryland School of Medicine—of 317 surgeons who performed, on average, 212 laparoscopic operations annually, found that 86.9 percent of respondents had physical discomfort or symptoms attributable to performing MIS.14,15 In the same survey, the researchers found that only 58.7 percent of the surgeons reported adequate awareness of steps to counteract ergonomic concerns.14

In 2011, 1,407 surgeons responded to a survey conducted by the Stanford University Medical Center (SUMC), which questioned the level of discomfort experienced from all types of procedures—open, laparoscopic, and robotic. Among respondents, nearly 61 percent reported ergonomic symptoms, and of this population, 55.4 percent attributed the symptoms to laparoscopic surgery, 36.3 percent to open surgery, and 8.3 percent to robotic surgery. Robotic surgery was more likely to lead to eye pain, and more likely than open surgery to lead to finger pain.16

“We viewed our survey as a first step in understanding what’s happening in the OR,” said the survey’s author, Tim Plerhoples, MD, a third-year resident in the SUMC department of surgery. “The issue of ergonomics seems to be gaining traction,” Dr. Plerhoples indicated, and unlike 20 years ago, surgeons are starting to acknowledge ergonomic issues and to look for ways around them.

“I’m suggesting that we need to study the issues more,” Dr. Park said. “Ergonomics should be classified as one of the basic surgical sciences.” Dr. Nichol agreed, saying, “I think it’s time for the American College of Surgeons to conduct a survey of all its members so we can get to the bottom of the question: ‘How many surgeons are being sidetracked by ergonomic pain?’”

Dr. Wren has a vision of an ergonomic specialist who would watch surgeons in practice and offer suggestions to make their jobs more efficient and less physically painful. “Professional violinists have ergonomic specialists who help them overcome potential damage to their muscles,” Dr. Wren said. “Shouldn’t surgeons have them too?”

**OR can be a real pain—even for young surgeons**

Ergonomic issues may surprise some young surgeons, who have not experienced or noticed the wear and tear on their bodies. Dr. Park participated 14 years ago in an ergonomic experiment conducted by a fledgling industrial economics group at the University of Kentucky, Lexington, while he was a practicing surgeon at the university hospital. The study tested the impact of laparoscopic surgery on the surgeon’s fatigue and work production.

As Dr. Park performed a routine laparoscopic cholecystectomy, a procedure that took him less than 25 minutes to complete, the researchers studied the biomechanics of his movements.

“I thought they would report that I had performed like ‘poetry-in-motion,’” Dr. Park said. He was astounded when the researchers informed him that if he were a small business, they would have to shut him down. “The results pointed to ergonomic risk factors that violated industrial standards,” he said. Specifically, the researchers found that movements involved with the laparoscopic procedure had a biomechanical impact reflected by muscle strain, sustained contraction, and excessive joint deflection. The findings showed that the MIS surgeon’s tendency to draw his arms away from the midline of his body took a toll on his arm and wrist muscles.
“This was really the first firm indication to me that there was a problem,” Dr. Park said. “I soon realized the dearth of materials covering the subject of surgery and ergonomics. As surgeons, we know what posture and movement should look like, but we have little data to support our theories.”

“More surgeons are raising questions about ergonomics, but this is still a relatively new field,” Dr. Park said. “We need to begin by sitting down with our industrial partners in a cooperative search for answers. I am convinced that the solutions to these problems will come through multidisciplinary, coordinated efforts.”

“Ergonomics is a field that is wide open for investigation,” according to Dr. Park, and there is plenty of work left to be done. “I tell young surgeons, ‘This is an opportunity to carve out some answers in a field where there are still so many questions.’”

In the end, he said, ergonomic issues aren’t just surgeons’ problems. “We have a whole population of stakeholders, including health policy planners, hospital administrators, insurance companies, and of course, patients—many of whom don’t yet realize they are in an environment where demands for surgeons are growing,” Dr. Park said. “The last thing any of us wants to count on as we address a looming surgeon shortage is a shortened surgical career.”

References


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